Computer Organization
Introduction

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Computer Organization

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  Office Hours by appointment

- Text: ***Computer Organization, Design, and Architecture (5th edition)***, Sajjan Shiva
- *Class notes available at*

  http://hurson.weebly.com/cs-3803-computer-organization.html

Computer Organization

- Grading Policy
  - In class exams & Quizzes: 40%
  - Final Exam (Comprehensive): 35%
  - Home works and Projects: 20%
  - Active class participation 5%
  - Individual grade will be determined based on individual effort, individual effort relative to the class effort, and proactive participation in the class.

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- Hardcopy of homeworks and Projects are collected in class,
- It is encouraged to work as a group (at most two people per group) on homeworks/project (grouping is fixed through out the semester),
- May 1st is the deadline for filing grade corrections; no requests for grade change/update will be entertained after this deadline.

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- Course is composed of several modules, you will be given a test at the end of each module.
- Modules are self paced. If you are familiar with the contents of a module or if you finish a module ahead of the class, you can contact me to test out that module.
- I am expecting you to look at the slides ahead and prior to the class period.

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Note, this unit will be covered in two lectures. In case you finish it earlier, then you have the following options:

1) Take the early test and start CS3803.module2
2) Study the supplement module (supplement CS3803.module1)
3) Act as a helper to help other students in studying CS3803.module1

Note, options 2 and 3 have extra credits as noted in course outline.

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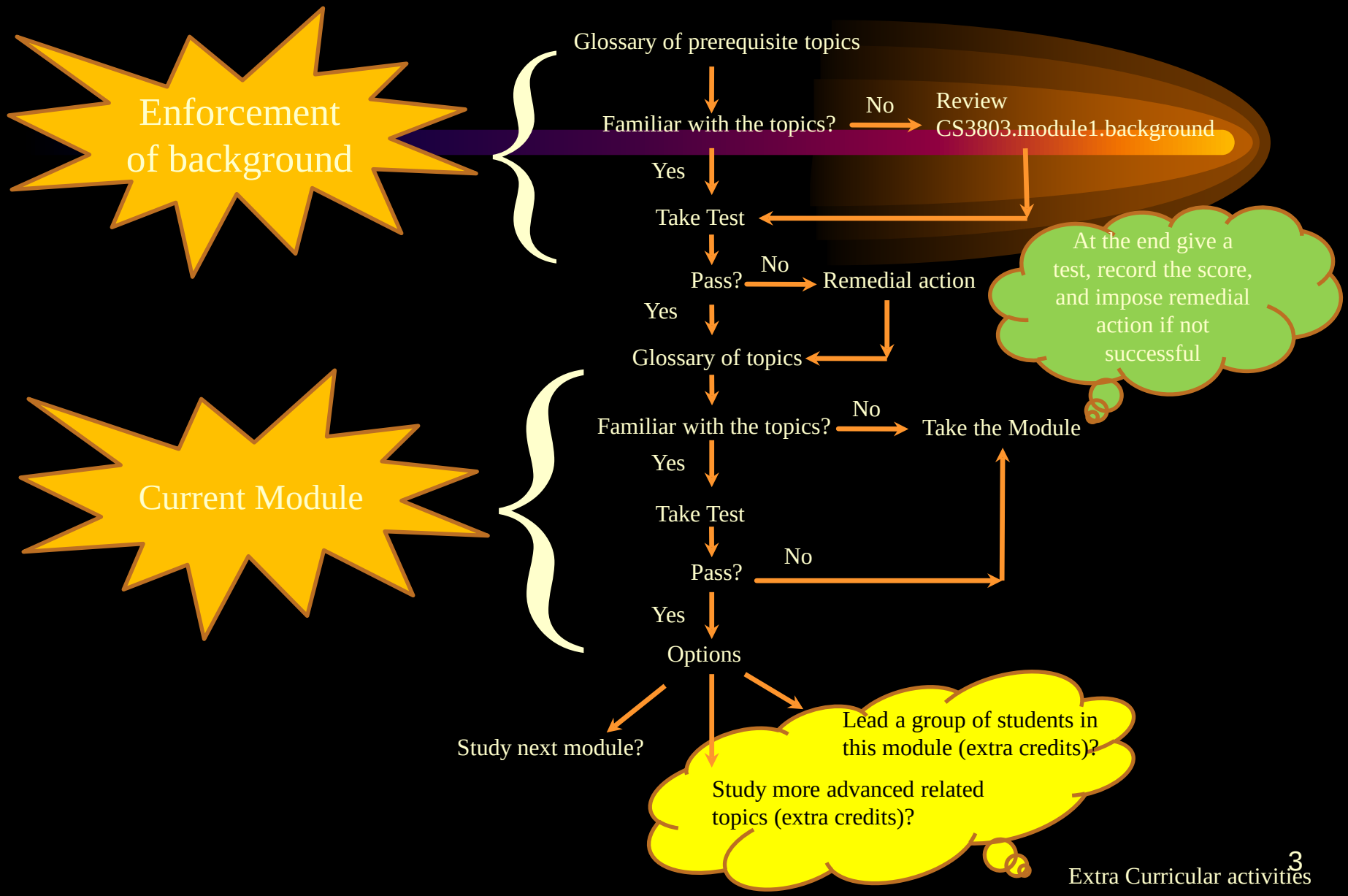

Extra Curricular activities

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- **Introduction** – Predicting the Future
  - Everything that can be invented has been invented – *Charles Duell, U.S. Office of Patents, 1900*
  - Where a calculator on the ENIAC is equipped with 18,000 vacuum tubes and weighs 30 tons, computers in the future may have only 1,000 vacuum tubes and perhaps weigh 1.5 tons – *Popular Mechanics, March 1949*
  - There is no reason for any individual to have a computer in his home – *Ken Olsen, President of Digital Equipment, 1977*
  - No one will ever need more than 640K of RAM – *Bill Gates*

- **Introduction** – Universe in One Year
  - Imagine that the history of the universe is compressed into one year — with the big bang occurring in the first seconds of New Year's Day, and all our known history occurring in the final seconds before midnight on December 31.
  - Using this scale of time, each month would equal a little over a billion years.

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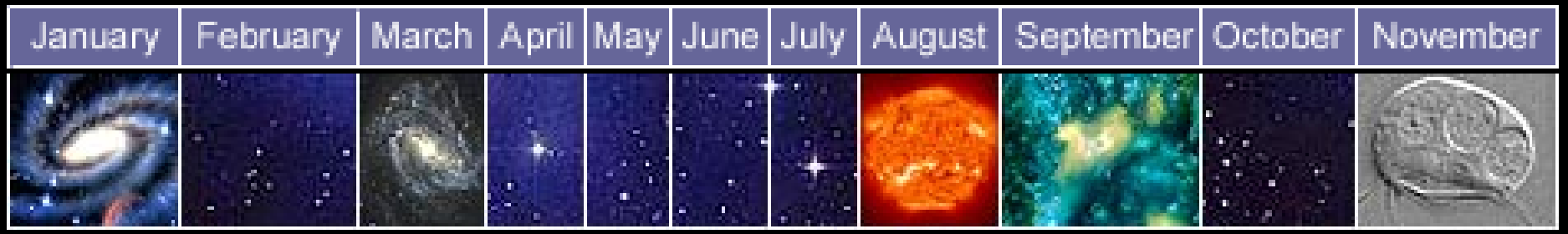
- **Introduction** – Universe in One Year



New Year's day: The Big Bang

Milky Way forms

Sun and Planets form

Oldest Known Life (single celled)

First Multi-cellular Organisms

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- **Introduction** – Universe in One Year

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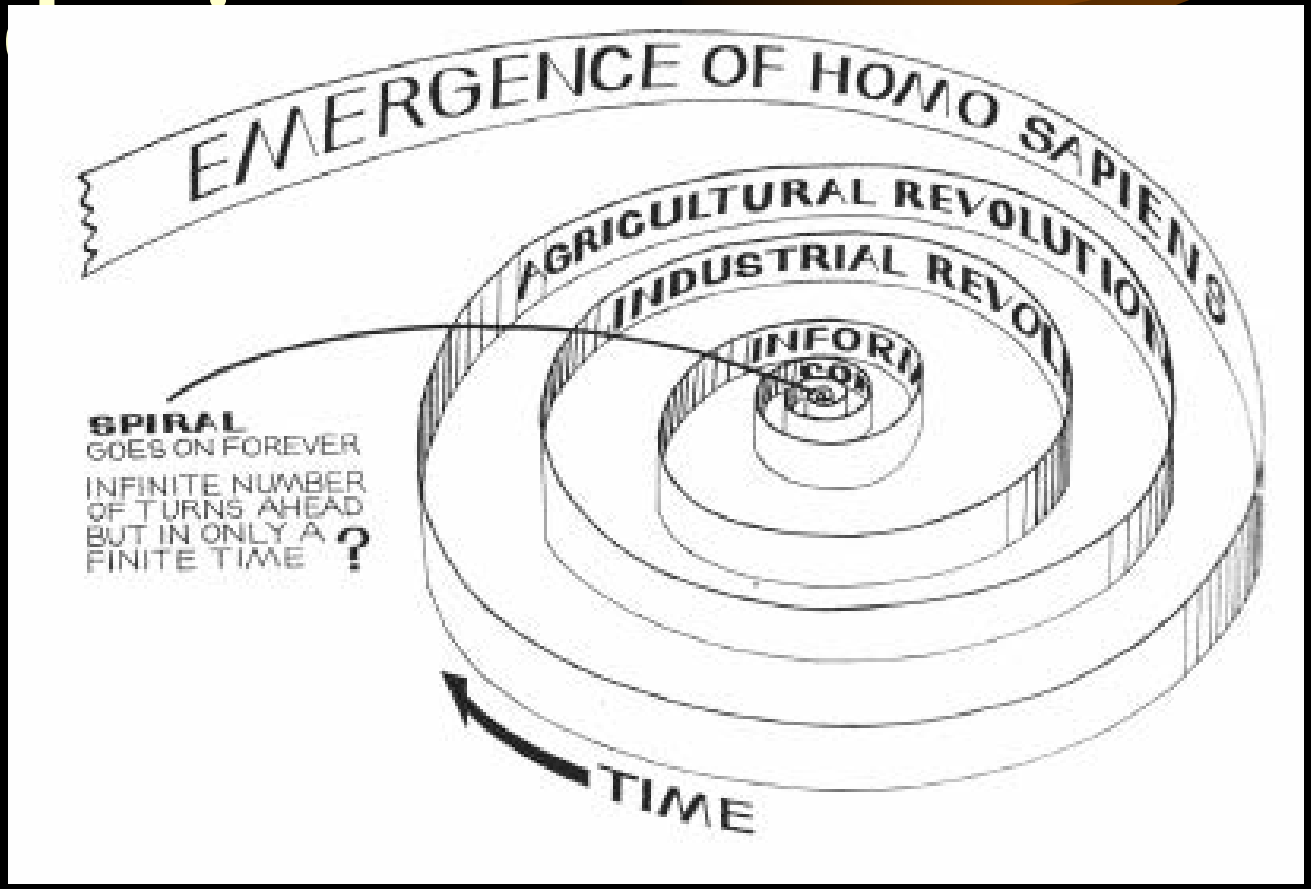
- **Introduction**



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- **Introduction** – Modern Time
  - Industrial Age 1770-1950
  - Information Age 1950….
  - Much less than a second within the Yearly Universe! – How Much did we accomplish?

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- **Introduction** – Changes
  - For the 20th century, Overall Technological Progress doubled every 10 years:
    - 1900 – 1950 Technology increased 32 folds
    - 1900 – 2000 Technology increased 1000 folds
    - 1900 – 2010 Technology will increase 2000 folds
    - 1900 – 2100 Technology will increase over 1,000,000 folds
    - The first ten years of the 21st century technological changes will be equivalent to everything that happened in the 20th century!

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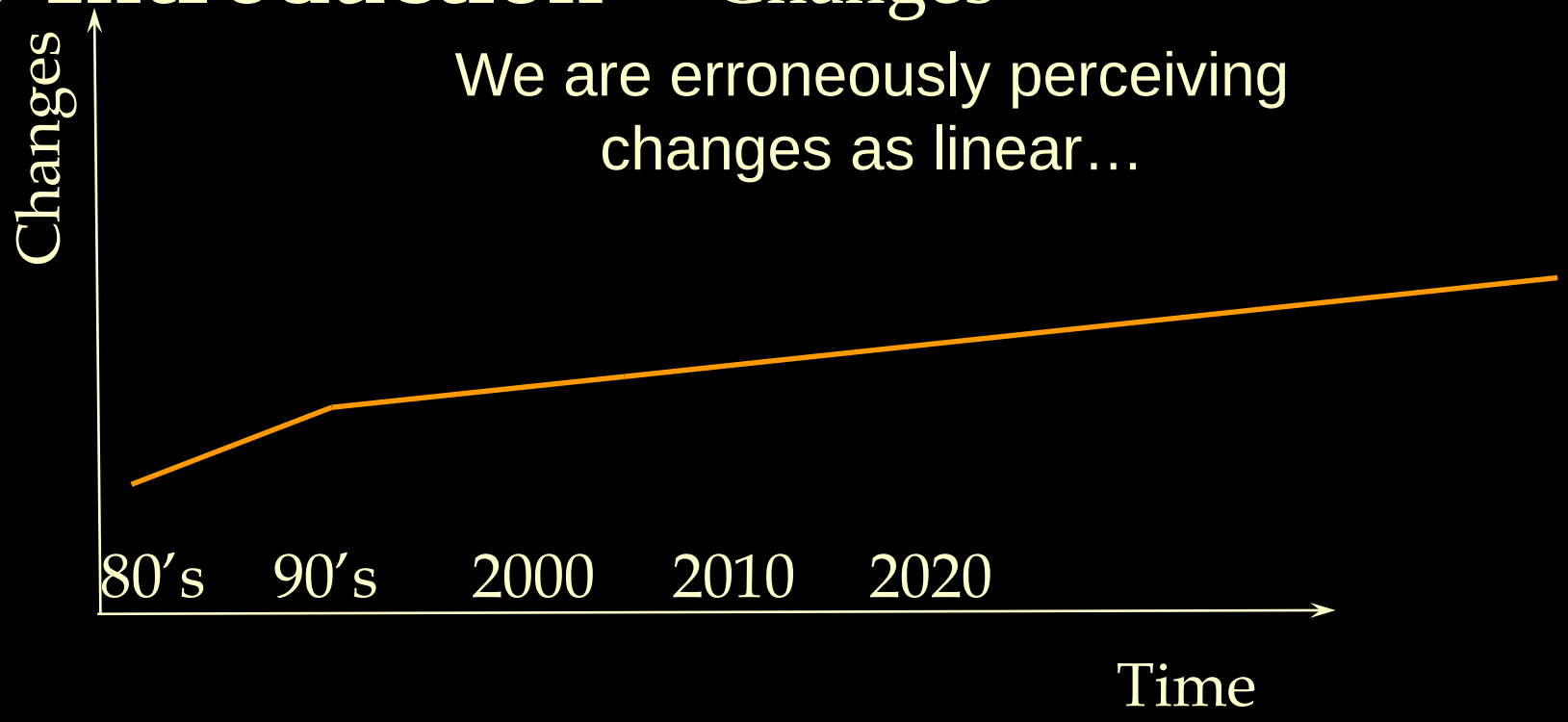
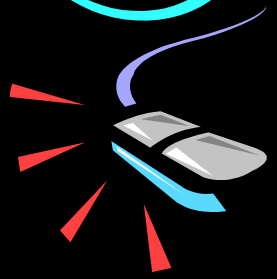
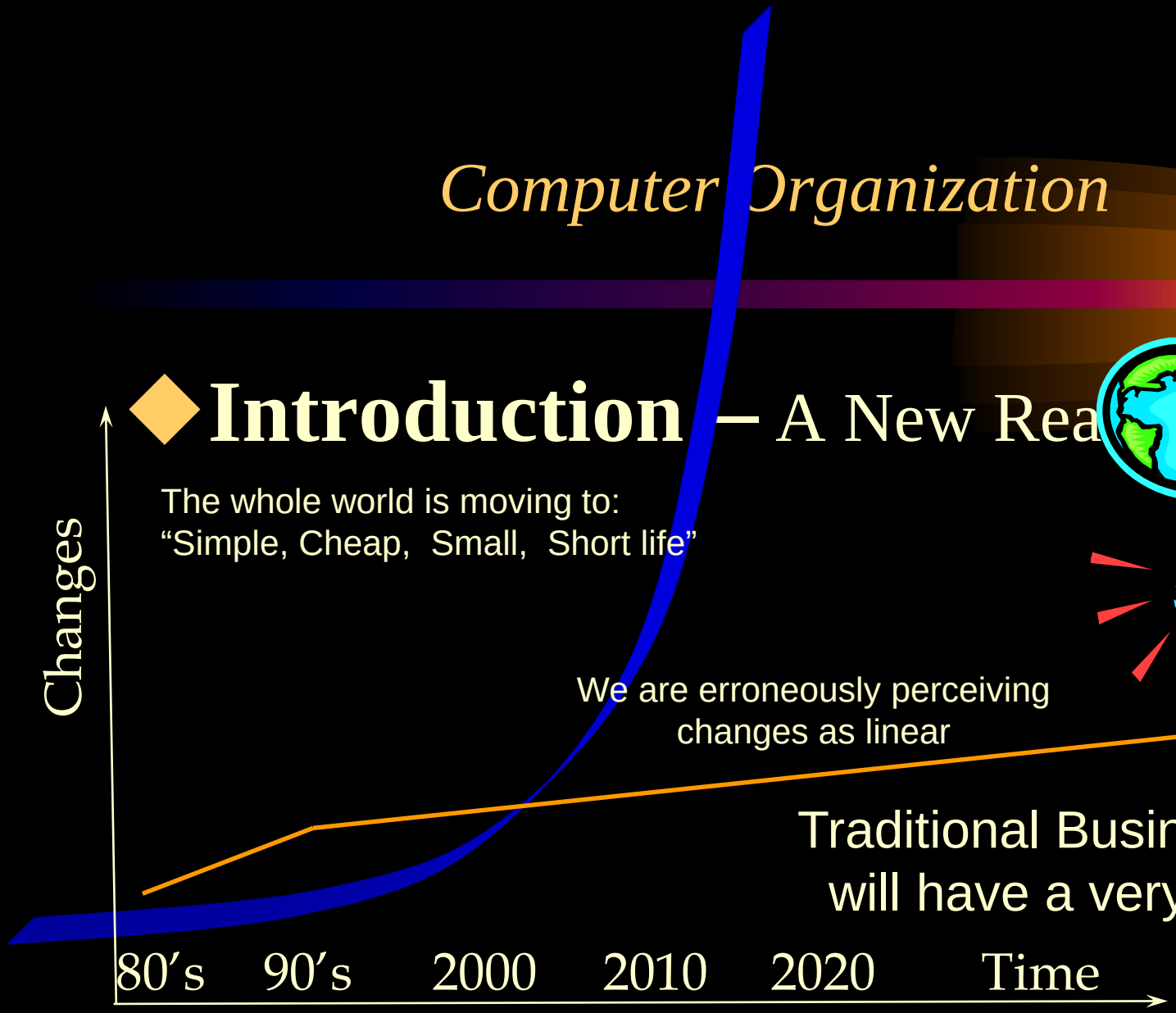
- **Introduction** – Changes



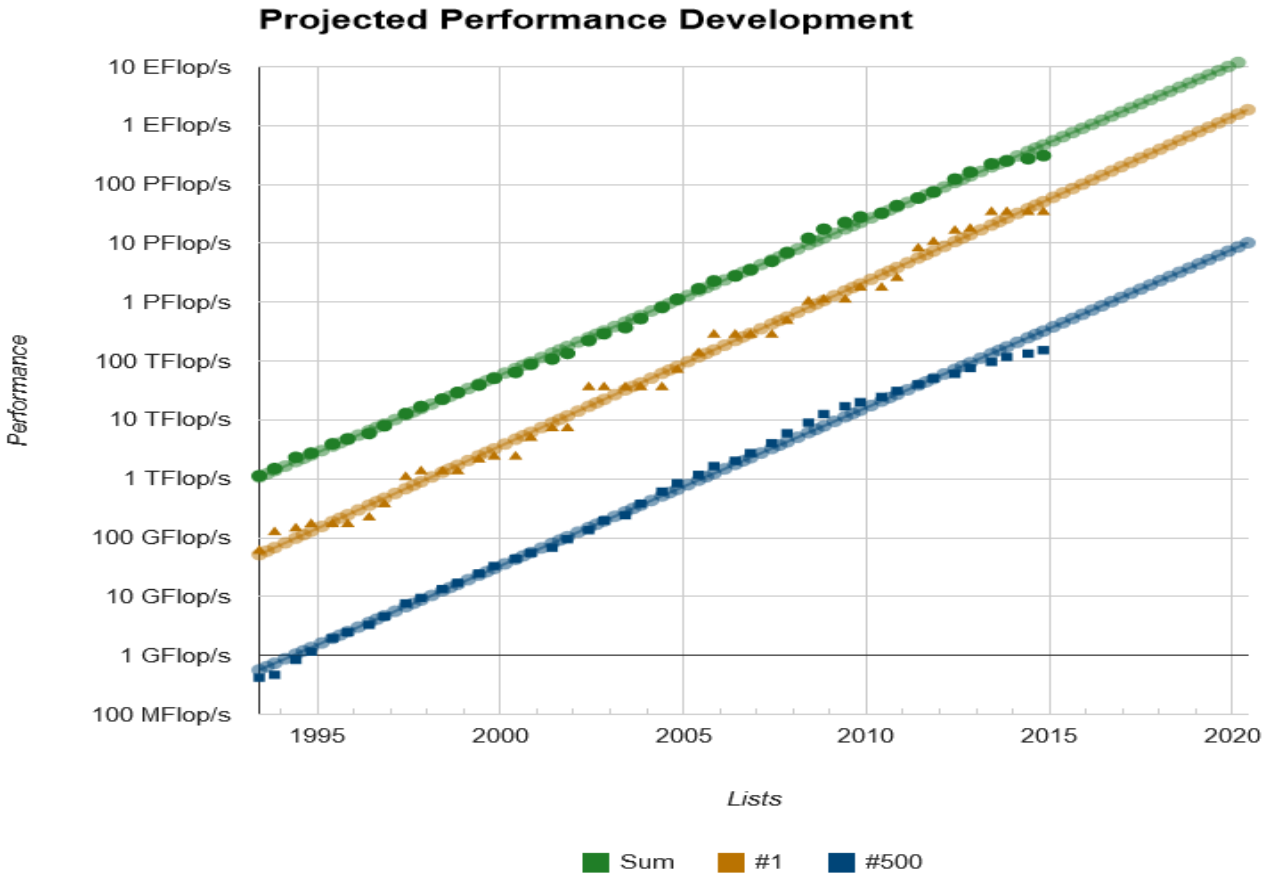
Introduction – A New Rea

The whole world is moving to:
"Simple, Cheap, Small, Short life"





Race to the Top



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- **Introduction**
  - Why this course?
  - What is its objective (s)?
    - This course attempts to study a computer.
    - So one has to find out what a computer is.

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Introduction

- A computer, like any other system, is a collection of entities (components) interconnected in order to perform a well defined function. This function is determined by the functions performed by its components and by the manner in which they are interconnected.
- The function of the computer is a mapping of the input data to the output data:

$$F: A \rightarrow B$$

- In case of a digital system *A* and *B* are digital or discrete quantities.

Computer Organization

Introduction

- The **study of computers** is the study of its components, their interactions and their parallel activities and co-operations.
- In this course a computer is viewed as a collection of five interconnected components:
  - Input Unit
  - Output Unit
  - Memory Unit
  - **C**entral **P**rocessing **U**nit (CPU):
    - **C**ontrol **U**nit (CU)
    - **A**rithmetic **L**ogic **U**nit (ALU)

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Introduction

- **Input Unit:** is an interface between the outside world and the internal parts. It performs two tasks: **Transmission** and **Translation** of information.
- **Output Unit:** is an interface between the internal parts and the outside world. Its functions are the same as the Input Unit.
- **Memory Unit:** acts as storage. It stores the instructions, data, intermediate, and final results.
- **Central Processor Unit:** is used to:
  - Interpret the instructions and initiate their executions.
  - Perform arithmetic and logical operations on the data.

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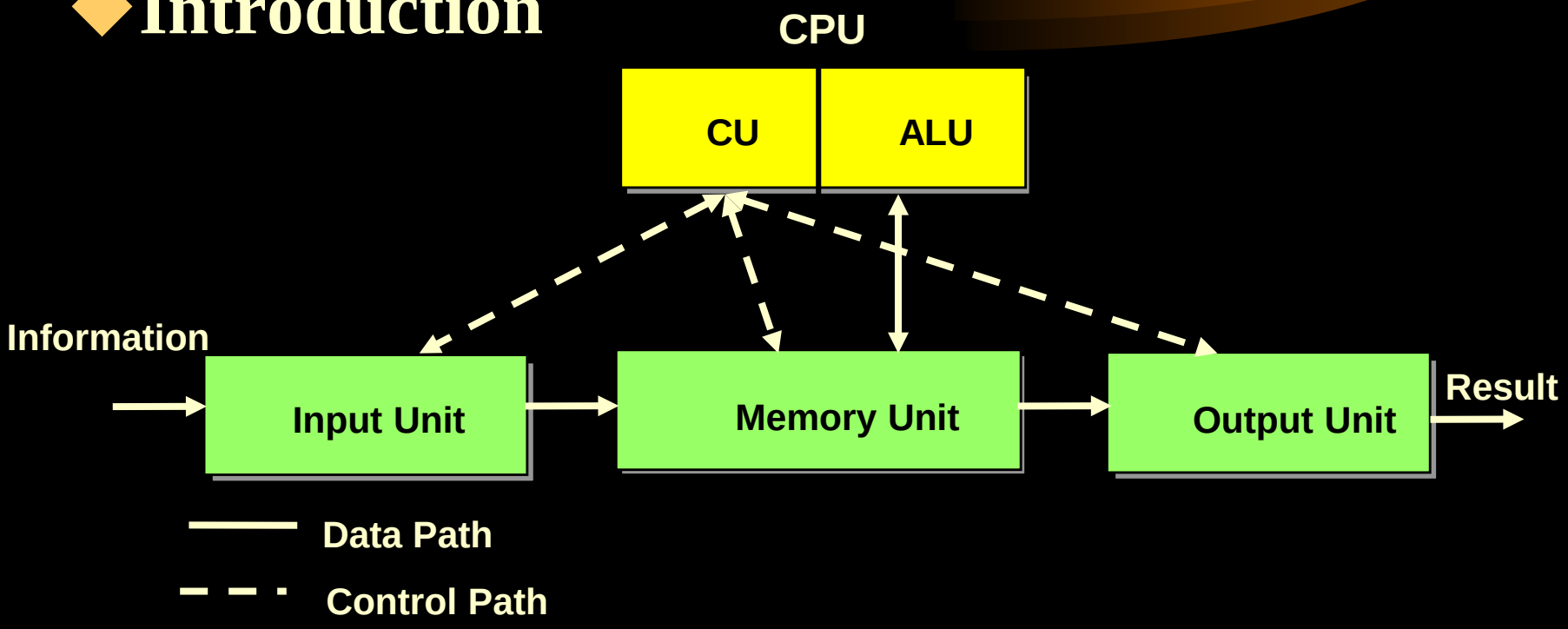
- **Introduction**



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Introduction

- In general, a computer can be studied at four different levels: Electronic, Logic, Programming, and System. Though it is hard to generalize, usually:
  - Electronic level is the subject of physics and mathematics,
  - Logic level is the subject of electrical engineering, and
  - Programming and System levels are the subjects of computer science/computer engineering.

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Level	Components
Electronic	Active: transistor, voltage sources Passive: resistor, capacitor
Logic combinational sequential register	 gates, AND, OR, ... Flip Flops, ... register, data, operators, ...
Programming compiler interpreter machine oriented assembly machine micro • • •	
System	control, processor, ...

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Introduction

- A digital system can be viewed as a combinational and/or sequential device. Therefore, it can be evaluated at the combinational and/or sequential sublevels.
- Similarly, a computer system can be studied in terms of the functions it could handle. This is the basis for **Logic Transfer Level**.
- At Logic Transfer Level, one requires a set of notations (language) to carry out such evaluation. This method is called **Register Transfer Logic** and the language is called **Register Transfer Language**.

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Introduction

- We take a **top-down approach** to study a complex object.
  - A complex object is recursively broken down into its components.
  - At each level, we study the components and the inter-actions among them.
- In this course a computer will be studied at Logic and Programming levels and later on at System level.
- We will try to define a set of notations and rules in order to be able to study and analyze a computer.

Computer Organization

- **Introduction**
  - **Computer**: A device capable of solving problems (data manipulation) by accepting data, performing prescribed operations on the data, and supplying the results.
  - **Central processing unit**: The component of a computer system with the capability to control the interpretation and execution of the instructions. The CPU includes the arithmetic-logic unit and the control unit.

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- **Introduction**
  - **Primary Memory**: Also called Primary memory. It is a volatile memory that that holds the program and intermediate data during the course of a program execution.
  - **Secondary Memory**: A nonvolatile memory that is used to hold the program and data between the runs.

Computer Organization

- **Introduction**
  - **Assembly Language**: A symbolic representation of machine language.
  - **Assembler**: A compiler that translates assembly language to machine language.
  - **Translation**: To change information from one form of representation to another without changing the meaning.
  - **μ operation**: A basic operation that is executed during a clock cycle.

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- **Introduction**
  - **Transmission**: The act of sending information from one location and the receiving of the same information in another location.
  - **Logic Transfer Level**: A method in which a computer is studied based on its functionality.
  - **Register Transfer Language**: A tool which allows to represent, study, and analyze a computer at the Logic Transfer Level.

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- Some Facts
  - Processor
    - Logic capacity: increases about 30% per year
    - Performance: 2x every 1.5 years
  - Memory
    - DRAM capacity: 4x every 3 years
    - Memory speed: 1.5x every 10 years
    - Cost per bit: decreases about 25% per year
  - Disk
    - Capacity: increases about 60% per year

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- **Questions**
  - Why are we interested in computer?
  - What is a machine dependent language?
  - What is the difference between machine dependent and machine independent languages?
  - What is the difference between assembly instruction and machine instruction?
  - What is the difference between the assembly instruction and the micro instruction?

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- **Questions**
  - Define the term “Little Endian”.
  - Define the term “Big Endian”.
  - Define the term “Instruction Format”.